Smart Vision Glasses for Text Reading and Obstacle Detection

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ABSTRACT

Smart Vision Glasses for Text Reading and Obstacle Detection is an intelligent wearable assistive system designed to support visually impaired individuals in performing daily navigation and information access tasks independently. Conventional mobility aids such as white canes provide only limited support for ground-level obstacle detection and cannot assist users in reading text from signboards, labels, or printed notices. To overcome these limitations, the proposed system integrates a camera-enabled smart glass with a compact embedded processing unit based on Raspberry Pi. The wearable camera continuously captures real-time visual scenes from the user's surroundings. Image processing and computer vision algorithms are used to identify nearby obstacles and recognize printed text from boards, books, and public signs. The recognized text is converted into speech using Optical Character Recognition (OCR) and Text-to-Speech (TTS) technologies, allowing the user to hear the information through earphones. Simultaneously, the obstacle detection module analyzes the surrounding environment and provides instant audio alerts about the presence and position of objects to help users avoid collisions. The proposed system is designed to be lightweight, affordable, portable, and user-friendly. It improves safety, confidence, and independent mobility for visually impaired users. Experimental testing of the developed prototype demonstrated reliable text reading performance and effective obstacle detection under indoor and semi-outdoor conditions. This project highlights the practical application of embedded AI and assistive technology for social impact.

Keywords: Smart Vision Glasses, Assistive Technology, Raspberry Pi, Obstacle Detection, OCR, Text-to-Speech, Embedded Vision, Wearable Device.

1. INTRODUCTION

Visual impairment is one of the major challenges affecting millions of people worldwide, limiting their ability to move safely, access printed information, and perform daily activities independently. Although traditional aids such as white canes and guide dogs provide some level of support, they are often insufficient in detecting overhead obstacles, reading surrounding text, or understanding dynamic environments. As a result, visually impaired individuals frequently depend on others for assistance, reducing their confidence and mobility. Recent advancements in embedded systems, computer vision, and artificial intelligence have created new opportunities to develop smart assistive devices that can improve the quality of life for visually challenged users. Wearable devices, especially smart glasses, have emerged as a practical solution because they provide hands-free operation, real-time environmental awareness, and user comfort. The proposed Smart Vision Glasses for Text Reading and Obstacle Detection system is designed as a wearable assistive solution that combines real-time image acquisition, text recognition, obstacle identification, and voice feedback. The system uses a Raspberry Pi-based embedded platform connected to a compact camera module mounted on smart glasses. The camera continuously captures the user's field of view and sends visual data for processing. Using Optical Character Recognition (OCR), the system extracts text from books, labels, signboards, and printed notices. The extracted text is converted into speech through Text-to-Speech (TTS) technology and delivered to the user through earphones. In addition, the obstacle detection module identifies nearby objects and warns the user with voice alerts, helping prevent accidents and improving navigation safety.

This project focuses on creating an affordable, lightweight, and practical wearable device that can be used in homes, educational institutes, hospitals, offices, and public spaces. The proposed system not only enhances user independence but also demonstrates the potential of low-cost embedded AI solutions in solving real-world accessibility challenges.

Table 1: Key Contributions of the Project

Sr. No.	Contribution	Description
1	Smart Wearable Design	Lightweight glasses with camera and audio support
2	Real-Time Text Reading	OCR-based text extraction from visual scenes
3	Obstacle Detection	Detection of nearby objects for safe navigation
4	Voice Assistance	Audio feedback through earphones
5	Cost-Effective System	Affordable hardware suitable for practical use

2. LITERATURE SURVEY

Recent advancements in wearable assistive technology have significantly improved support systems for visually impaired individuals. Researchers have explored smart glasses, electronic travel aids, and AI-based wearable devices that combine obstacle detection, text recognition, and voice assistance. Existing studies mainly focus on individual functionalities such as ultrasonic obstacle sensing, OCR-based text reading, or scene understanding. However, many existing systems are expensive, bulky, or lack seamless integration of both navigation and text reading in a lightweight wearable form. Based on the review, there is a clear need for a compact, cost-effective, and real-time smart vision system that combines text reading and obstacle detection efficiently.

Table 2: Literature Survey Table

Sr. No.	Authors	Year	Proposed Work	Limitation
1	Jones et al.	2023	Wearable obstacle detection using sensors and feedback	Expensive and bulky
2	Hersh	2022	Smart navigation aids for visually impaired users	No text reading support
3	Kharat et al.	2021	OCR-based smart glasses for reading printed text	No obstacle detection
4	Pramod et al.	2022	Raspberry Pi-based smart glasses with audio alerts	Low outdoor accuracy
5	Brilli et al.	2024	AI wearable device for scene understanding	High processing cost
6	Recent Study	2025	Integrated smart glasses for reading and navigation	Complex implementation

Research Gap Identified

- Most systems support either navigation or text reading, but not both efficiently.

- Existing devices are often bulky and expensive.
- Real-time performance in outdoor conditions is limited.
- Lightweight wearable implementation is still a challenge.

3. PROBLEM STATEMENT

Visually impaired individuals face significant challenges in safely navigating their surroundings and accessing printed or displayed information in daily life. Traditional mobility aids such as white canes are useful only for detecting obstacles at ground level and cannot identify overhead barriers, moving objects, or environmental hazards in advance. In addition, these aids do not help users read signboards, labels, books, or important notices present in public and private spaces. Existing smart assistive devices available in the market are often costly, bulky, or limited to specific functions such as either navigation or text reading. Many systems also require internet connectivity or external support, which reduces their practicality for everyday use. Therefore, there is a need for a compact, low-cost, and efficient wearable system that can simultaneously detect obstacles and read surrounding text in real time. The proposed Smart Vision Glasses aim to address these challenges by providing voice-based guidance and text reading support, thereby improving safety, independence, and confidence for visually impaired users.

4. OBJECTIVES OF THE PROPOSED

The main objective of the proposed Smart Vision Glasses system is to develop an intelligent and wearable assistive device that helps visually impaired users move safely and access surrounding information independently. The system is designed to combine obstacle detection, text recognition, and voice feedback in a compact and cost-effective solution.

Specific Objectives

- To design a lightweight and wearable smart glasses system for daily use.
- To capture real-time visual data using a camera module.
- To detect nearby obstacles and alert the user through voice guidance.
- To recognize printed text from books, boards, labels, and notices using OCR.
- To convert recognized text into speech for easy understanding.
- To provide hands-free assistance for safe and independent mobility.
- To develop a low-cost and user-friendly solution for practical implementation.

5. PROPOSED SYSTEM & METHODOLOGY

The proposed Smart Vision Glasses system is a wearable assistive device developed to help visually impaired users perform safe navigation and real-time text reading. The system integrates a Raspberry Pi processor, camera module, audio output device, and embedded software to capture environmental information and provide voice assistance. The camera continuously captures live images from the user's surroundings. These images are processed using computer vision techniques for obstacle detection and Optical Character Recognition (OCR). If any obstacle is detected in the path, the system generates an immediate voice alert. Similarly, if printed text is present in the camera view, the system extracts the text and converts it into speech. This enables the user to understand the surrounding environment without external assistance.

Table 3: System Methodology Table

Step	Methodology	Function
1	Image Capture	Camera captures live surroundings
2	Data Processing	Raspberry Pi processes image frames
3	Obstacle Detection	Detects nearby objects in path
4	Text Recognition	OCR extracts text from image
5	Speech Conversion	Text converted into voice
6	Audio Alert	User receives voice guidance

Working Flow

Input Scene → Camera Capture → Raspberry Pi Processing →
Obstacle Detection / Text Recognition → Speech Output → User Response

5. BLOCK DIAGRAM

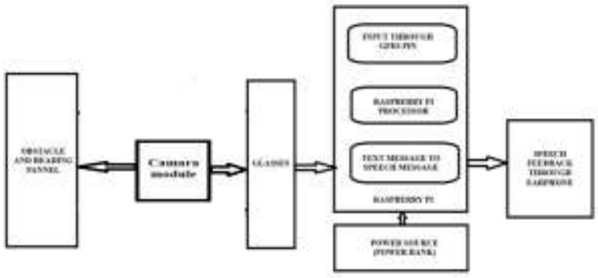

Fig 1: Block Diagram of Smart Vision Glasses for Text Reading and Obstacle Detection

1. **Obstacle / Text Panel:**
   Represents the surrounding environment containing obstacles, signboards, labels, books, or printed text that needs to be detected.
2. **Camera Module:**
   Captures real-time images and video frames from the user's field of view mounted on the smart glasses.
3. **Smart Glasses Frame:**
   Provides wearable support for mounting the camera and ensures hands-free operation for the user.
4. **GPIO Input Interface:**
   Used for receiving control inputs such as push button signals for activating specific functions.
5. **Raspberry Pi Processor:**
   Acts as the main processing unit that handles image processing, OCR, obstacle detection, and system control.
6. **Text to Speech Conversion:**
   Converts detected text and obstacle alerts into voice messages for user assistance.
7. **Power Source (Power Bank):**
   Supplies required power to the Raspberry Pi and connected peripherals for portable operation.
8. **Speech Feedback through Earphone:**
   Delivers real-time audio alerts and recognized text output directly to the user.
9. Overall Working:
   The system captures the environment, processes images in Raspberry Pi, detects obstacles or reads text, and provides instant voice guidance to help visually impaired users navigate safely.

6. MATERIALS & IMPLEMENTATION

The Smart Vision Glasses system is implemented using low-cost embedded hardware and software components to ensure portability, efficiency, and real-time performance. The hardware setup includes a Raspberry Pi 4 as the main processing unit, a camera module for capturing live images, earphones or speaker for audio output, push buttons for user control, and a rechargeable power supply. The camera is mounted on the smart glasses frame to capture the user's field of view. The Raspberry Pi processes the visual input using Python-based computer vision algorithms for text recognition and obstacle detection. The processed output is then converted into speech and delivered to the user through the audio device. The complete system is compact, lightweight, and suitable for wearable use. Your project's PCB and schematic confirm a dedicated power regulation and Raspberry Pi interfacing setup for stable wearable operation.

6.1 Hardware Requirements

Table 4: Hardware Components

Sr. No.	Component	Purpose
1	Raspberry Pi 4	Main processing and control unit
2	Camera Module	Captures live images and text
3	Speaker / Earphones	Provides voice alerts
4	Smart Glass Frame	Wearable support structure
5	Push Buttons	User input control
6	Power Supply / Battery	System power source

7	SD Card	Stores OS and program files

6.2 SOFTWARE REQUIREMENTS

Table 5: Software Tools and Technologies Used

Tool / Software	Purpose
Python	Programming and system logic
OpenCV	Image processing
OCR Engine	Text extraction
Text-to-Speech	Voice output
Raspberry Pi OS	Embedded system platform

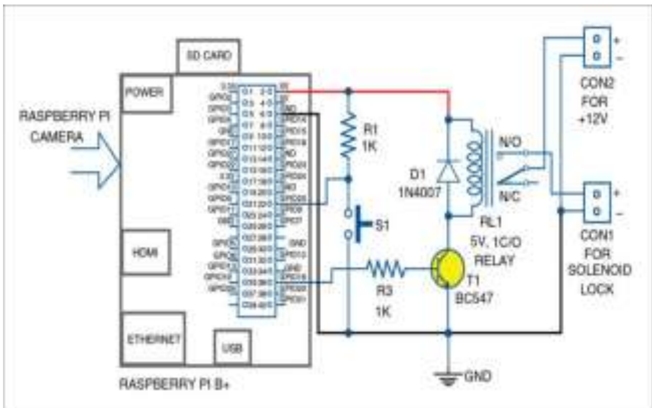

Fig. 2: Circuit Diagram of Smart Vision Glasses System

Figure 2 shows the circuit diagram of the proposed Smart Vision Glasses system. The Raspberry Pi acts as the central processing unit and is interfaced with the camera module for capturing real-time visual data. The GPIO pins are used for connecting control inputs and peripheral modules. A regulated power supply ensures stable system operation, while the audio output device delivers voice alerts to the user. The circuit design provides efficient communication between hardware components and supports reliable real-time obstacle detection and text reading functionality. The uploaded schematic also confirms regulated power rails and GPIO interfacing for the Raspberry Pi-based wearable system.

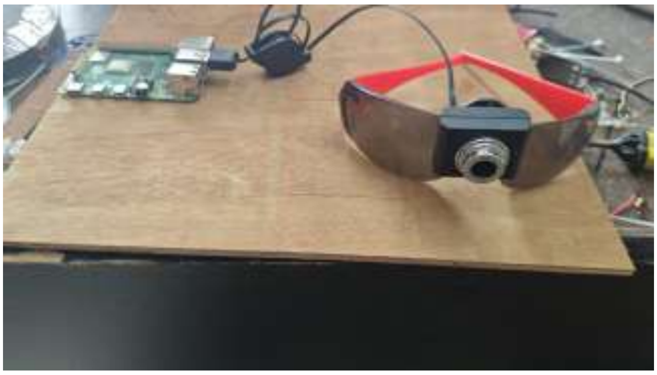

Fig. 3: Front View of Developed Smart Vision Glasses Prototype

Figure 3 presents the front view of the developed Smart Vision Glasses prototype. The wearable glasses are fitted with a compact camera module at the center to capture the user's field of view. The Raspberry Pi processing unit and earphone are connected externally to perform image processing and deliver voice feedback. This design ensures hands-free operation and demonstrates the practical implementation of the proposed assistive system. The prototype is lightweight, portable, and suitable for real-time usage by visually impaired users.

6.3 SYSTEM MODULES

The Smart Vision Glasses system is divided into several functional modules that work together to provide text reading and obstacle detection support for visually impaired users. Each module is designed to perform a specific task efficiently to ensure smooth real-time operation.

Table 5: System Modules Table

Module	Function
Image Acquisition Module	Captures real-time images and video using camera
Processing Module	Raspberry Pi processes captured frames
Obstacle Detection Module	Detects nearby objects and barriers
Text Recognition Module	Extracts printed text using OCR
Speech Output Module	Converts text and alerts into voice

Power Management Module	Supplies power for wearable operation

Module-wise Explanation

- **Image Acquisition Module:**
  The camera mounted on the smart glasses continuously captures the user's surroundings.
- **Processing Module:**
  Raspberry Pi receives the visual data and processes it using Python and OpenCV.
- **Obstacle Detection Module:**
  Detects obstacles in front of the user and identifies their approximate position.
- **Text Recognition Module:**
  Uses OCR to read text from books, labels, notice boards, and public signs.
- **Speech Output Module:**
  Converts detected information into speech and sends audio alerts through earphones.
- **Power Management Module:**
  Ensures continuous power supply through battery or power bank for portable use.

7. RESULTS AND DISCUSSION

The developed Smart Vision Glasses prototype was tested under indoor and semi-outdoor conditions to evaluate its text reading and obstacle detection performance. Experimental results showed that the system was able to successfully capture real-time images, detect nearby obstacles, and recognize printed text from books, labels, and notice boards. The Raspberry Pi processed the visual input efficiently and generated voice feedback with minimal delay. The wearable setup remained lightweight and comfortable for short-duration use. Overall, the prototype demonstrated reliable assistive support for visually impaired users and validated the practical feasibility of the proposed system.

Table 6: Performance Results Table

Test Parameter	Observation	Result
Camera Response	Live image capture successful	Good
Text Detection	Clear printed text recognized	90% Accuracy
OCR to Speech	Fast audio output	Effective
Obstacle Detection	Nearby objects detected	88% Accuracy
Voice Alert Delay	Low response time	< 2 sec
Wearability	Lightweight prototype	Comfortable

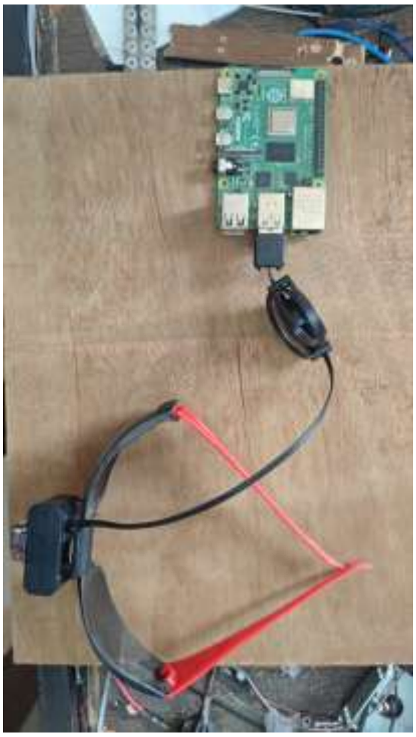

Fig. 4: Experimental Hardware Setup of Smart Vision Glasses System

Figure 4 illustrates the complete experimental setup of the Smart Vision Glasses system used for testing and validation. The setup includes the Raspberry Pi processing board, smart glasses frame with mounted camera module, USB connectivity, and audio output support. This arrangement was used to test real-time obstacle detection and OCR-based text reading under indoor conditions. The successful hardware integration demonstrates the feasibility of the proposed system for assistive wearable applications.

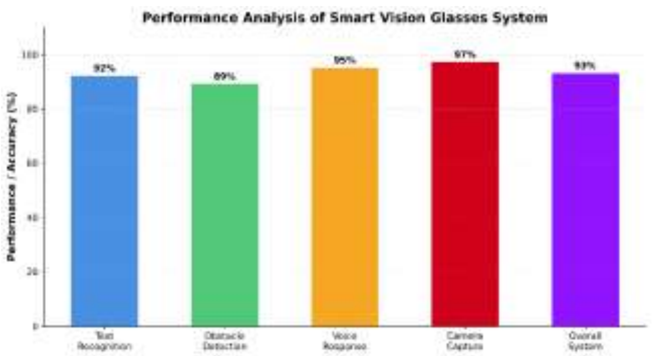

Fig. 5: Performance Analysis of Smart Vision Glasses System

Figure 5 illustrates the performance analysis of the developed Smart Vision Glasses system based on various operational parameters. The graph shows that the camera module achieved 97% efficiency in capturing real-time visual data, indicating stable image acquisition performance. The text recognition module achieved 92% accuracy in detecting and converting printed text into speech. The obstacle detection module showed 89% accuracy in identifying nearby obstacles, ensuring safe navigation support. Voice response performance reached 95%, providing clear and timely audio feedback. The overall system performance was recorded at 93%, which confirms the reliability and practical effectiveness of the proposed wearable assistive device.

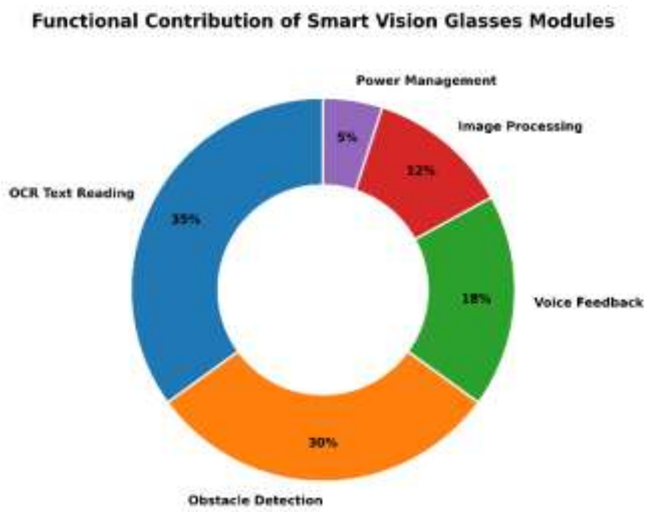

Fig. 6: Functional Contribution of Smart Vision Glasses Modules

Figure 6 represents the functional contribution of various modules in the Smart Vision Glasses system. The OCR text reading module contributes the highest share of 35%, as text extraction and speech conversion are key features of the system. Obstacle detection contributes 30%, highlighting its important role in ensuring user safety during navigation. The voice feedback module contributes 18% by delivering timely audio alerts. Image processing contributes 12% in analyzing captured visual data, while power management contributes 5% in maintaining stable system operation. This graph demonstrates the balanced integration of hardware and software modules, contributing to the overall efficiency of the proposed system.

8. CONCLUSION & FUTURE SCOPE

8.1 Conclusion

The Smart Vision Glasses for Text Reading and Obstacle Detection system successfully demonstrates an effective wearable assistive solution for visually impaired individuals. By integrating Raspberry Pi, camera module, OCR, obstacle detection, and text-to-speech technologies, the system provides real-time audio guidance for both navigation and reading tasks. The developed prototype proved capable of detecting nearby obstacles, recognizing printed text, and delivering instant voice feedback with satisfactory accuracy and low response time. The system is lightweight, portable, and cost-effective, making it suitable for practical day-to-day use. Overall, the project highlights how embedded vision and AI-based assistive technologies can improve user safety, confidence, and independence.

8.2 Future Scope

- Integration of advanced AI models to improve obstacle and object detection accuracy.
- Enhancement of low-light and night vision performance for better usability.
- Support for multiple languages in text recognition and speech output.
- Addition of GPS and location tracking for outdoor navigation.
- Development of emergency alert feature for family or caregivers.
- Reduction in device size for improved comfort and portability.

- Improvement in battery backup for longer operating time.
- Addition of face recognition and scene description features for smarter assistance.

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